

What is claimed is:

1 1. A method for processing a single channel audio signal to provide a plurality of
2 audio-channel signals, comprising:

3 separating said single channel audio signal into a first separated signal
4 characterized by a spectral pattern generally characteristic of speech, and a second
5 separated signal;

6 processing said first separated signal to provide a first audio-channel signal; and
7 modifying said second separated signal to produce the remainder of said plurality
8 of audio-channel signals.

1 2. A method for processing an audio signal in accordance with claim 1, wherein
2 said modifying includes:

3 dividing said second separated signal into a plurality of signals; and
4 multiplying one of the latter signals by a predetermined factor.

1 3. A method for processing an audio signal in accordance with claim 2, wherein
2 said factor is variable with respect to time.

1 4. A method for processing an audio signal in accordance with claim 2 wherein
2 said factor applies a gain that is proportional to the time averaged magnitude of said first
3 separated signal divided by the sum of the time averaged magnitude of said first separated
4 signal and the time averaged magnitude of said second separated signal.

1 5. A method for processing an audio signal in accordance with claim 1, wherein
2 said modifying includes

3 dividing said second separated signal into a plurality of signals; and
4 time-delaying ^{at least one of} said second separated signal ^{and said plurality of signals}.

1 6. A method for processing an audio signal in accordance with claim 1, wherein
2 said modifying step provides a left channel signal and a right channel signal.

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1 7. A method for processing an audio signal in accordance with claim 6, wherein
2 said modifying step further provides a left surround channel signal and a right surround
3 channel signal.

1 8. A method for processing a single channel audio signal in accordance with claim
2 1, wherein said first audio channel signal is a center channel signal.

1 9. A method for processing a single channel audio signal in accordance with claim
2 8, wherein said processing said first separated signal includes multiplying said first
3 separated signal by a first predetermined factor.

1 10 A method for processing a single audio signal in accordance with claim 9,
2 wherein said modifying step comprises the step of multiplying said second separated signal
3 by a second predetermined factor.

1 11. A method for processing a single audio signal in accordance with claim 10,
2 wherein said first predetermined factor and said second predetermined factor are
3 determined such that an increase the signal strength of said first separated signal coincides
4 with a decrease in the signal strength of said second separated signal.

1 12. A method of processing a single channel audio signal in accordance with claim
2 9, wherein said first predetermined factor is variable with respect to time.

1 13. A method for processing a single channel audio signal in accordance with
2 claim 9, wherein said predetermined factor is proportional to the time averaged magnitude
3 of said first separated signal divided by the sum of the time averaged magnitude of the first
4 separated signal and the time averaged magnitude of the second separated signal.

1 14. An audio signal processing apparatus for processing a single-channel audio
2 signal to provide a plurality of audio channel signals, comprising
3 a separator, for separating said audio signal into a first separated signal
4 characterized by a frequency spectrum characteristic of speech, and a second separated
5 signal; and
6 a first circuit coupled to said separator responsive to said second separated signal

7 for providing a first subset of said plurality of audio channel signals, coupled to said
8 speech separator.

1 15. An audio signal processing apparatus in accordance with claim 14, wherein
2 said first circuit comprises multiple signal paths for said second separated signal,
3 one of said multiple signal paths furnishing a time delay.

1 16. An audio signal processing apparatus in accordance with claim 14, wherein
2 said first circuit comprises multiple signal paths,
3 at least one of said multiple signal paths comprising a multiplier.

1 17. An audio signal processing apparatus in accordance with claim 16, wherein
2 said first multiple signal paths are constructed and arranged to subtractively combine a
3 signal to which said variable gain has been applied with a signal path to which said variable
4 gain has not been applied.

1 18. An audio signal processing apparatus in accordance with claim 14, wherein
2 said first subset of said plurality of audio channel signals comprises a left channel signal
3 and a right channel signal.

1 19. An audio signal processing apparatus in accordance with claim 18, wherein
2 said first subset of said plurality of audio channel signals comprises a left surround channel
3 signal and a right surround channel signal.

1 20. An audio signal processing apparatus in accordance with claim 14, wherein
2 said separator includes a bandpass filter having a pass band corresponding substantially to
3 the band of spectra characteristic of speech.

1 21. An audio signal processing apparatus in accordance with claim 14, further
2 comprising a second circuit coupled to said separator and responsive to said first
3 separated signal for providing a second subset of said plurality of audio channel signals.

1 22. An audio signal processing apparatus in accordance with claim 21, wherein
2 said second subset comprises a single audio channel signal.

1 23. An audio signal processing apparatus in accordance with claim 22, wherein
2 said single audio channel signal is a center channel signal.

24. An audio signal processing system comprising;
an input terminal for a single input channel signal;
a center channel output terminal for a center channel output signal *C*;
a plurality of other output terminals, for a corresponding plurality of other output audio channel signals;
a separator for separating said single channel input signal into a speech audio signal and a nonspeech audio signal;
a first circuit coupling said speech audio signal to said center channel terminal, and
a second circuit, coupling said separator and said plurality of output terminals responsive to said nonspeech signal, providing a corresponding plurality of other audio channel signals.

25. An audio signal processing system in accordance with claim 24, wherein said second circuit comprises multiple signal paths, one of said multiple signal paths furnishing a time delay.

26. An audio signal processing system in accordance with claim 24, wherein said circuit comprises multiple signal paths,
at least one of said multiple signal paths comprising a multiplier.

27. An audio signal processing system in accordance with claim 26, wherein said multiplier is coupled to an other output terminal that is a left channel output terminal

28. An audio signal processing system in accordance with claim 26, wherein said multiplier is coupled to an other output terminal that is a right channel output terminal.

29. An audio signal processing system in accordance with claim 24, wherein said separator comprises a bandpass filter having a pass band corresponding substantially to the spectrum of speech signals.

30. An audio signal processing system in accordance with claim 24, further comprising a multiplier coupling said separator to said center channel output terminal and multiplying the output of said separator by a predetermined factor.

1 31. An audio signal processing system in accordance with claim 30, wherein said
2 predetermined factor is variable with respect to time.

1 32. An audio signal processing system in accordance with claim 30 wherein said
2 predetermined factor is proportional to the time averaged magnitude of said speech audio
3 signal.

1 33. An audio signal processing system in accordance with claim 32 wherein said
2 predetermined factor is proportional to the time averaged magnitude of said speech audio
3 signal divided by the sum of the time averaged magnitude of the speech audio signal and
4 the time averaged magnitude of said nonspeech audio signal.

1 34. An audio signal processing system in accordance with claim 24, wherein said
2 second circuit provides a left channel signal L , a right channel signal R , a left surround
3 channel signal L_s , and a right surround channel signal R_s ,

4 further comprising a downmixing circuit coupled to said plurality of other output
5 terminals and to said center channel output terminal, for downmixing said plurality of
6 other output audio channel signals and said center channel signal to provide a plurality of
7 decodable audio channel signals.

1 35. An audio signal processing apparatus in accordance with claim 34, wherein
2 said plurality of decodable audio channel signals consists of two decodable audio channel
3 signals.

1 36. An audio signal processing apparatus in accordance with claim 34, wherein
2 said plurality of decodable audio channel signals consists of three decodable audio channel
3 signals.

1 37. A method for processing a single channel audio signal to provide two
2 decodable audio channel signals decodable into five audio channel signals, comprising:

3 separating said single channel audio signal into a first separated signal
4 characterized by a spectral pattern generally characteristic of speech, and a second
5 separated signal;

6 processing said first separated signal to provide a center channel signal C ;

7 processing said second separated signal to provide a left channel signal L , a right
8 channel signal R , a left surround channel signal L_S , and a right surround channel signal R_S ;
9 combining said center channel signal, the sum signal of said left surround and said
10 right surround channel signals, and said left channel signal to produce a first of said two
11 decodable audio channel signals; and
12 combining said center channel signal, said sum of said left surround and said right
13 surround channel signals, and said right channel signal to produce a second of said two
14 decodable audio channel signals.

1 38. A method for processing a single channel audio signal in accordance with claim
2 37, further comprising scaling said center channel signal and said sum of said left surround
3 and said right surround channel signals by center and surround factors respectively

1 39. A method for processing a single channel audio signal in accordance with claim
2 38, further comprising reversing the phase of said sum component comprising one of said
3 first and second decodable audio signal relative to said sum component comprising the
4 other decodable audio signal.

1 40. A method for processing a single channel audio signal to provide three
2 decodable audio channel signals subsequently decodable into five audio channel signals,
3 comprising:

4 separating said single channel audio signal into a first separated signal
5 characterized by a spectral pattern generally characteristic of speech, and a second
6 separated signal;

7 processing said first separated signal to form a center channel signal comprising a
8 first decodable audio signal;

9 processing said second separated signal to provide a left channel signal, a right
10 channel signal, a left surround channel signal, and a right surround channel signal;

11 combining a sum of said left surround and said right surround channel signals with
12 said left channel signal to produce a first of said two decodable audio channel signals; and

13 combining said sum of said left surround with said right surround channel signals,
14 and said right channel signal to produce a third of said decodable audio channel signals.

1 41. A method for processing a single channel audio signal in accordance with claim
2 40, further comprising scaling by a predetermined surround factor.

1 42. A method for processing a single channel audio signal in accordance with claim
2 41 further comprising reversing the phase of one of said sum comprising one of said
3 second and third decodable audio signals relative to the other of and said second and third
4 decodable audio signals.

1 43. A method for processing two input audio channel signals to provide more than
2 two output audio channel signals comprising:

3 separating each of said two input audio channel signals into a first separated signal,
4 characterized by a spectral pattern generally characteristic of speech, and a second
5 separated signal;

6 combining said first separated signal of said first input audio channel signal with
7 said first separated signal of said second input audio channel signal to form a first of said
8 more than two output audio channel signals;

9 said second separated signal of said first input signal comprising a second of said
10 more than two output audio channel signals; and

11 said second separated signal of said second input signal comprising a third of said
12 more than two output channel signals.

13 44. A method for processing two input audio channel signals in accordance with
14 claim 43, wherein said second separated signal of said first input signal comprises a
15 ~~provides a~~ left channel signal and said second separated signal of said second input signal
16 comprises a right channel signal.

1 45. A method for processing two input audio channel signals in accordance with
2 claim 43, wherein said first of said more than two output audio channel signals comprises
3 a center channel signal.

1 46. A method for processing two input audio channel signal in accordance with
2 claim 43, further comprising

3 differentially combining said second separated signal of said first input signal with
4 said second separated signal of said second input signal to form a fourth of said more than

5 two output audio channel signals; and
6 differentially combining said second separated signal of said second input signal
7 with said second separated signal of said first input signal to form a fifth of said more than
8 two output audio channel signals.

1 47 An audio signal processing apparatus for processing two audio channel signals
2 to provide more than two output audio channel signals comprising,

3 a first separator, for separating a first of said two audio channel signals into a first
4 separated signal characterized by a spectral pattern characteristic of speech and a second
5 separated signal comprising a first of said more than two output audio channel signals;

6 a second separator, for separating a second of said two audio channel signals into a
7 first separated signal characterized by a spectral pattern characteristic of speech, and a
8 second separated signal comprising a second of said more than two output audio channel
9 signals; and

10 a first combiner, for combining said first separated signal of said first audio channel
11 signal and said first separated signal of said second audio channel signal to provide a third
12 of said more than two output audio channel signals.

1 48. An audio signal processing apparatus in accordance with claim 47, further
2 comprising

3 a second combiner for differentially combining said first output audio channel
4 signal with said second output channel signal to provide a fourth of said more than two
5 output audio channels; and

6 a third combiner for differentially combining said second output audio channel
7 signal with said first output audio channel to provide a fifth of said more than two output
8 audio channels.